Microbial Respiration Measured in the Gulf of Maine During a 21-Day Research Expedition

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Background: Marine Microbes

- Types include: bacteria, archaea, microalgae and viruses
- Exist in complex communities
- Make up ~98% of biomass in the ocean[1]
- Microbial metabolism influences energy flux and higher trophic levels
- Indicators of environmental changes in ocean
- Table 1 shows how environmental factors affect microbial respiration. The Gulf of Maine is exceptionally vulnerable to changes in environmental factors due to climate change.

Environmental Factor	Predicted Effect on Microbial Resp.
Water Temp. ↑	↑
pH ↓	↓
Nutrient Input ↑	↑
Available Sunlight ↑	↑
Depth ↑	↓ *
Biomass ↑	↑

Table 1. The * indicates that after the chlorophyll max. depth the respiration will decrease

Background: Field Sampling

- CTD (**C**onductivity, **T**emperature, **D**epth) was used to collect water at each station across the Gulf of Maine on the ECOA-3 cruise (fig. 1a)
  - CTD determined the chlorophyll maximum (chl. max) depth
    - The chl. max is a depth below the surface where chlorophyll a concentrations are at a maximum. Light penetration and nutrient supply from depth creates this. This indicates high biomass[2] (fig. 1a)

Fig.1a Shows the stations marked on map of Gulf of Maine

Fig. 1b demonstrates the chl. max depth, denoted here as the DCM. Note the DCM peaks where nutrients are no longer limited and there is still sunlight available[2]

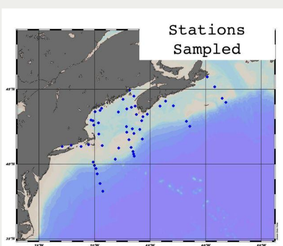

Fig. 1a

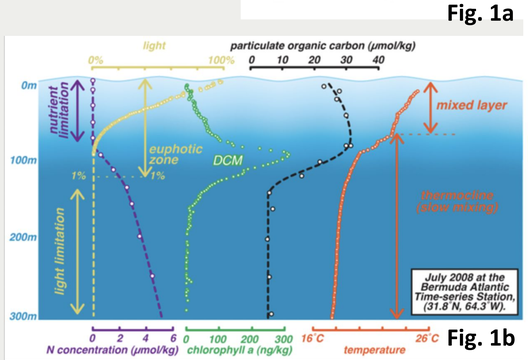

Fig. 1b

Procedure

- INT reduction assay[3] was done for each sample
  - Each station = 4 samples in total
    - 2 depths collected (surface and chl. max)
    - For each depth = 2 size classes of microbes (0.2-0.8 µm, and >0.8 µm)
  - Water samples incubated with redox dye INT
  - Water filtered with 0.2 and 0.8 µm filters
  - INT is then reduced to its insoluble form (INT-F) by ETS enzymes present in microbes; microbes collected on the filters
  - INT-F concentration of filters measured in the laboratory spectrophotometrically
  - Calculations using the concentration yields community microbial respiration rates

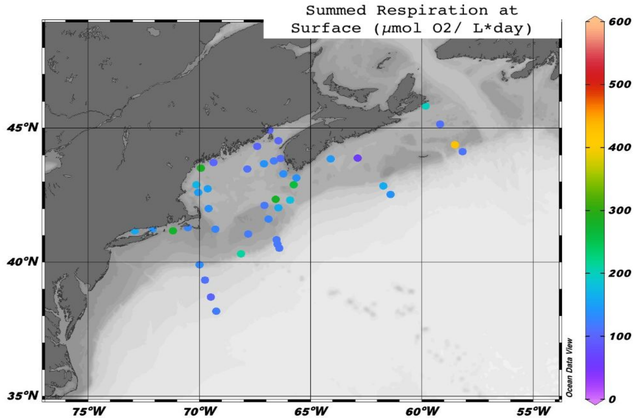

Fig. 4a

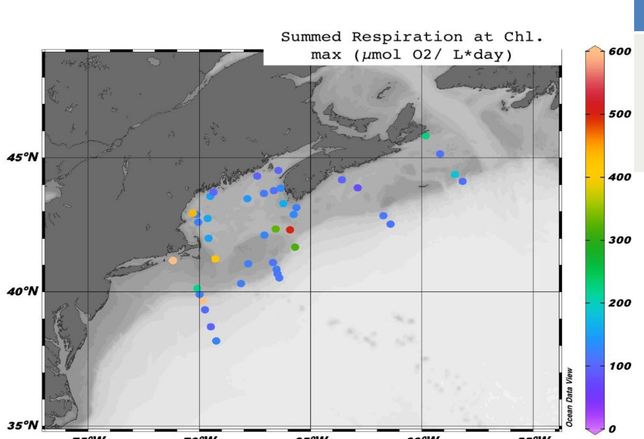

Fig. 4b

Fig. 4a and 4b were created by summing the respiration rates of both size classes at each station.

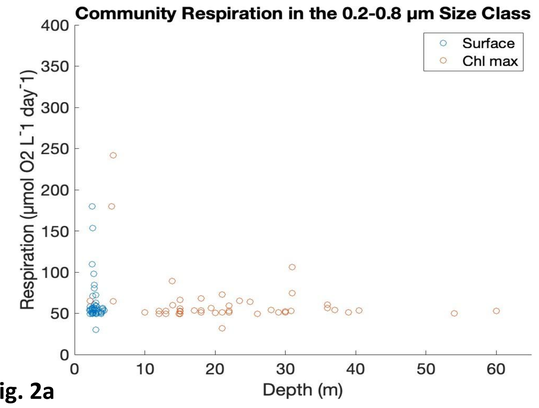

Fig. 2a

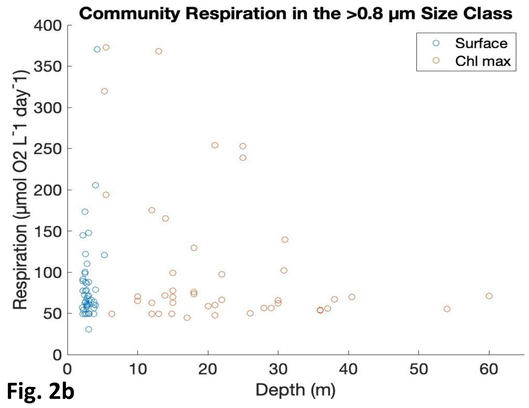

Fig. 2b

Comparison of fig. 2a and 2b shows that the larger size class yielded higher respiration rates. The larger size class indicates more biomass. Fig. 2b highlights that there is more variability in respiration rates at the surface than at the chl. max depth. Fig. 3a and 3b explore a possible reason why: temperature dependence. Fig 3a and b show no clear correlation between temperature and respiration. A correlation was ran on MatLab to determine statistical significance of the correlation and the variables were not found to be correlated. Higher temperature was observed at the surface (fig. 3a).

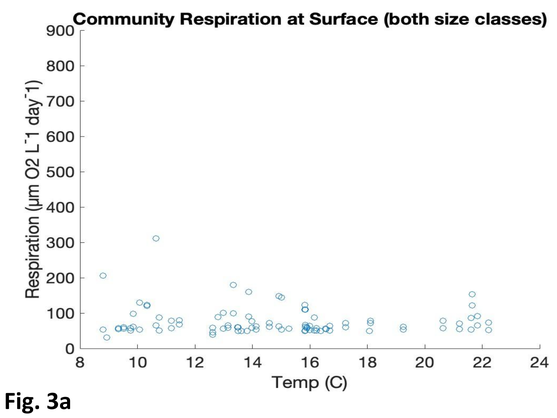

Fig. 3a

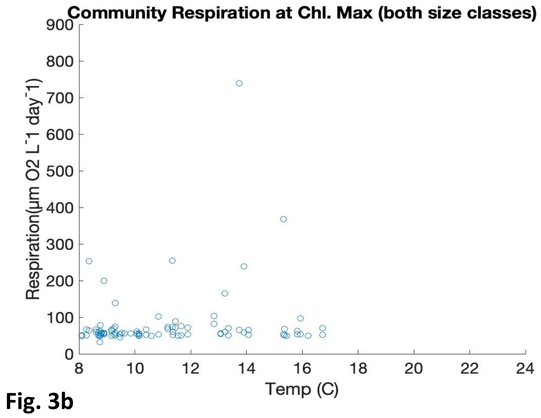

Fig. 3b

My Experience

I was at sea for 21 days; 7 of which I worked the night shift (00:00-12:00). It was an amazing experience. I worked side-by-side with oceanographers from across the country. I observed their different experiments and learned a lot. It was difficult living at sea sometimes I'll admit, but the knowledge and experience that I gained made it more than worth it. (Plus, I saw so many beautiful sunsets and dolphins)

Photos L to R: Me getting water from the CTD, the CTD being lowered, sunset off the bow, the bridge of the ship, a night shift schedule, the filter set-up, the NOAA ship I was aboard: *The Ronald Brown*

References

I would like to thank my capstone advisor, Kai Ziervogel and other scientists I worked with on the ECOA-3 cruise

[1]*What are marine microbes?* What are marine microbes? : Ocean Exploration Facts: NOAA Office of Ocean Exploration and Research. (n.d.). Retrieved April 7, 2023, from https://oceanexplorer.noaa.gov/facts/marinemicrobes.html

[2]Sigman, D. M. & Hain, M. P. (2012) The Biological Productivity of the Ocean. *Nature Education Knowledge* 3(10):21

[3]García-Martín, E. E., Seguro, I., & Robinson, C. (2019). Int reduction is a valid proxy for eukaryotic plankton respiration despite the inherent toxicity of INT and differences in cell wall structure. *PLOS ONE*, *14*(12). https://doi.org/10.1371/journal.pone.0225954